MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 1, 2016/2017

ECP3136 - DIGITAL IMAGE PROCESSING

(BE)

22 OCTOBER 2016
2.30 p.m – 4.30 p.m
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of 5 pages including cover page with 4 questions only.

2. Attempt ALL questions. All questions carry equal marks and the distribution of the marks for each question is given.

3. Please write all your answers in the answer booklet provided.

QUESTION 1

(a) When we enter a dark room on a bright day, it takes an appreciable interval of time before you can see well enough.

i) Which of the visual part in the human visual system is at play in this situation? Briefly explain your answer? [3 marks]

ii) Besides the factor of illumination, what other factor contributes to the intensity of any object that our human vision system can see? [1 mark]

(b) A gray level power law transformation method approach is employed to adjust the contrast of an image. It is given by the equation $s = cr^{\gamma}$ where $c = (L\text{-}1)^{(1-\gamma)}$. s represents the output pixel value, r being the input pixel value and L is the number of greylevels.

i) What would be the new output image $g[x,y]$ if the image $f[x,y]$ shown in Figure Q1.1 undergoes power law transformation with $c = 25.8$ and $\gamma = 0.35$. [5 marks]

ii) In your opinion, what effect does the process in (i) have on the output image $g[x,y]$? Comment in terms of brightness and verify your claim statistically. [7 marks]

$f[x,y]$

227	75	50	194
231	250	225	95
191	25	79	6
160	95	85	169
221	5	0	181

Figure Q1.1

(c) Table Q1 shows the probability of occurrences of pixel values $p_r(r_k)$ on a 7-bit image where n_k represents the number of pixels with greyvalue r_k. N and M represent the horizontal and vertical dimensions of the image respectively.

(i) If $n_2 = 32$, determine the mean pixel value of the whole image. [3 marks]

(ii) Determine the variance of pixel values for the whole image. [6 marks]

Table Q1

r_k	0	1	2	3	4	5	6	7
$p_r(r_k) = n_k/MN$	0.1	0.28	0.2	0.08	0.05	0.1	0.1	0.18

Continued .....

QUESTION 2

(a) Given the binary image in Figure Q2.1 consisting the shapes of several segmented objects represented as white pixels,

i) Identify the number of connected components. [1 mark]

ii) Design an approach based on mathematical morphology to produce the image as in Figure Q2.2. Clearly state the operation(s), structuring element(s) that are used to achieve the desired outcome. [6 marks]

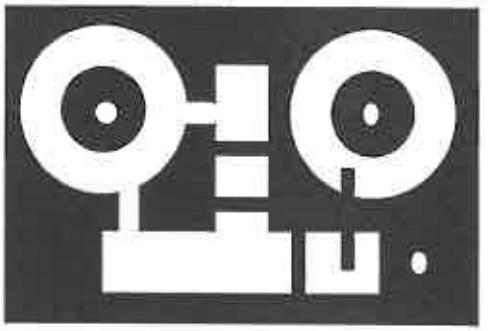

Figure Q2.1

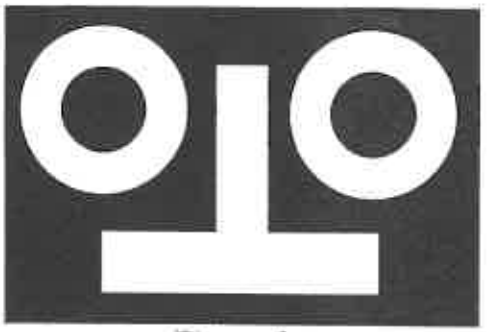

Figure Q2.2

(b) Design a binary image morphology process that can extract the primitive shape of the object shown in Figure Q2.3. Assume the object pixels as black pixels. The result of the process should produce the image shown in Figure Q2.4. Explain your answer by including information about the operation(s) and structuring element(s) used complete with illustrations. [6 marks]

Figure Q2.3

Figure Q2.4

(c) As an image analyst working with a company that provides solutions to customers on pathological image processing and analysis, you are assigned a task to design a system that is able to extract and count individual cells to assist pathologists in grading tissues. Based on your knowledge of digital image processing, propose steps to process the image shown in Figure Q2.5 so that we should be able to count the number of cells. Please explain your answer in a flowchart and clearly explain the chosen method and output of every single step. [12 marks]

Figure Q2.5

Continued .....

QUESTION 3

(a) Figure Q3.1 shows an intensity profile of a cross-section of an image. Sketch the 1st and 2nd derivative profile of the image intensity profile. Please mark the zero crossings in the 2nd derivative intensity profile. [6 marks]

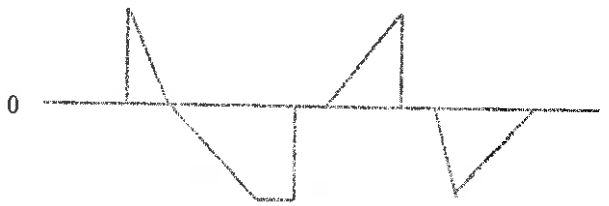

Figure Q3.1

(b) Consider the 4 × 4 gray image in Figure Q3.2. Calculate the *magnitude* and *direction* of gradient at each of the four pixel locations in the shaded region using the two operators shown in Figure Q3.3 and Figure Q3.4. [12 marks]

2	4	20	10
10	45	34	10
1	23	40	22
3	5	6	0

Figure Q3.2

-1	-1	-1
0	0	0
1	1	1

Figure Q3.3

-1	0	1
-1	0	1
-1	0	1

Figure Q3.4

(c) Figure Q3.5 shows a binary image containing an object represented by the darker pixels.

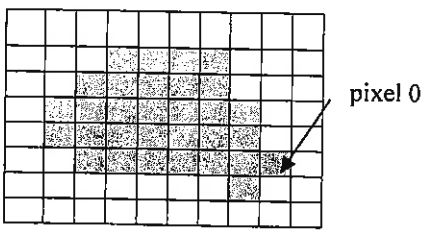

Figure Q3.5

(i) Describe how we can extract the *boundary* of the object based on mathematical morphology. Display the resultant image. [5 marks]

(ii) From the resultant boundary image of Question 3(c) (i), extract the 8-direction Freeman chain code of the contour starting from pixel 0 measured in counter-clockwise direction. [2 marks]

Continued .....

QUESTION 4

(a) List and elaborate on five applications of 3-D imaging technology in solving medical tasks. [10 marks]

(b) The similarity between projection radiography and nuclear medicine is both of them are based on ionizing radiation. What are two points of differences between them. [8 marks]

(c) Explain the working principles of a 3-D Prewitt edge detector. [7 marks]

End of Paper